Alternative approaches to estimating wildlife population trends: a test of community-based management

Introduction

The aim of wildlife management is generally to improve wildlife production, except for problem species causing loss of property or human life, in which case some form of control is normally carried out. In CBNRM programs, the community itself is developed as a critical part of the wildlife management process. In Zambia's CBNRM program, known as ADMADE, this is done by directly involving community members in wildlife policing, resource monitoring, and land use planning. In return, communities receive revenue shares from the various fees paid by tourist concessionaires and licensed hunters who harvest wildlife on their lands. In this way communities manage and develop their wildlife resources as a valuable economic benefit for helping improve living standards among community members.

The challenge for ADMADE in demonstrating improvements in wildlife production is to relate changes in community management efforts and land use habits to changes in wildlife numbers. In much of Zambia, this is especially problematic due to the nature of vegetation that limits the visibility for counting wildlife from aerial surveys. Not only do such surveys require external professional expertise, they are costly and for logistical reasons are difficult to repeat for statistically meaningful comparisons. Species that can be reliably counted (e.g. large mammals) tend to occur in widely scattered groups, which increases standard errors to levels that sometimes preclude any clear interpretation. In a recent survey by Jachmann (1998), for example, 95% confidence intervals for buffalo in some areas varied over a range from 0 to between 3000 and 14000. In one area the same aerial survey concluded that the area had become wildlife depleted whereas the safari operator for the same area in the same year decided to add a second safari hunting camp because of improved wildlife numbers and high hunting success for most species.. Such discrepancies suggest a potential risk when relying exclusively on aerial surveys.

Similar problems of even a greater magnitude can be sited for ground transects, especially if they are used to estimate population sizes for between-year comparisons. Experience in ADMADE has shown that such surveys require close supervision by highly qualified staff having adequate transport and readily available field staff. Such basic requirements cannot always be met. Numerous variables that influence animal movements in a hunting area when licensed hunting is being conducted often necessitate a large number of repeat samples per transect. Again, this limits the spatial scale that transects can sample and thus the usefulness and cost-effectiveness of transects for estimating population trends for large areas typical of Zambia's game management areas.

The problem of counting animals to evaluate population trends is an especially important one for ADMADE. This is because hunting revenues support much of the community incentives to manage and protect wildlife and that the sustainability of these revenues depends on how accurate hunting quotas reflect changes in population size. Rather than relying exclusively on

aerial census data, ADMADE has opted to use indirect measures of animal abundance for assessing population change by involving local residents to collect the required data. These indicators, or proxies, become more meaningful as their numbers increase and as their degree of independence for measuring population change increases. In terms of cost-effectiveness and usefulness in making between-year comparisons, the 'indicator' approach has certain advantages as compared to aerial surveys. These indicators are now being fully used by ADMADE to set quotas in many of the country's hunting areas and have resulted in significant changes presumed to be improvements over previous quotas. Despite this progress, there has not been any study carried out to verify the accuracy of these indicators and the population trends they predict.

The ADMADE Sustainability Project has undertaken this study to test the reliability of the 'indicator' approach as a scientifically accepted method for wildlife management. Given the need for CBNRM programs to be more community-driven in making technically sound resource management decisions, the results of this study are believed to have important implications for the efficacy of this approach. Results also provide an empirical basis for evaluating ADMADE's success in improving wildlife production.

Methodology

1) Background: proxies being used

The current ADMADE system for evaluating population trends relies on 6 key indicators with an additional two in development, all representing three different sources of information:

A. Hunter results:

These indicators are derived from the results of safari clients, who spend three to five months hunting in a typical hunting area, thus sampling a major portion of the area being managed. While data pertain to the availability of trophy quality animals, the following indicators help to evaluate the overall population supporting trophy quality production.

a. Mean trophy size: assesses the availability of quality trophy males in the population as a measure of population change
b. Hunting success: assesses the availability of trophy quality animals based on percentage of hunters who were looking for a specific species and succeeded in hunting it.
c. Hunting effort: used to assess the availability of trophy quality animals based on number of days hunters needed to find a suitable trophy animal of a particular species.

B. Third-party assessments:

These indicators are derived from formed questionnaires with three different groups of people, each not less than three consecutive years of extensive personal knowledge of the game management area up to the current date. The questionnaire examines a

person's perception of animal population trends over a three to five year period by suggesting whether a species' population is increasing, decreasing or unchanged. Additional details are asked to further explain the trends given for a particular species. For example, additional details may be needed to explain different trends occurring in different parts of the game management area for a given species. The questionnaire is administered to each individual privately to avoid possible influences from his peers. All respondents must have not less than three consecutive years of current experience in the area.

d. Professional hunter assessment: A resident hunting guide who accompanies safari clients.
e. Tracker: Typically a local resident employed by the professional hunter and accompanies all hunting parties in the area.
f. Village scout: A local resident employed by the community to monitor and police the wildlife in their area. Village scouts patrol actively throughout the year and cover approximately 40 to 80% of the area from these patrols.

C. Patrol results

g. Frequency of species' sighting: Selected species, normally 5, are monitored throughout the year by patrolling parties of village scouts. Their numbers are recorded as well as their location on a grid map. Between-year changes are compared to assess possible population changes.
h. Illegal off-take: A measure of animal mortality from illegal hunting is computed from data collected by scouts monitoring licensed hunter and while conducting field patrols. The measure is based on effort/yield indices for detecting snares and for poached animal carcasses either found or confiscated from people arrested.

Current data provide an interpretation of population trends from proxies a-f. Proxies g and h are still under development. Scores for proxies a-f consist of three categorical responses: + (increasing), 0 (no change) and – (decreasing). Weighting of individual scores is based on such factors as sample size, length of time respondent has been in the area, and so forth, but are necessarily simple to avoid making the procedures ambiguous and difficult to follow. A species population trend is therefore based on the accumulative score of these values.

Using the above methodology, a set of population trends were generated for key species being hunted in five game management areas in Luangwa Valley for 1998. Rather than using formed questionnaires to determine population trends from individual respondents, the exercise was done as a group. This procedure may have introduced a certain bias by the way individuals in the group expressed their opinions on population trends. The results of this work are summarized in the table below:

Table 1.

SpeciesID	Mwanya	Chanjuzi	Nyampala	Luawata	Chifunda	Chikwa
Buffalo	+	-	+	O	+	-
Bushbuck	+	+	O	O	+	+
Crocodile	+	O	+	+	+	+

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Duiker C	O	O	+	+	+	O
Eland	O (+)	O	+	+	-	O
Elephant	+	+	+	+	+	O
Grysbok	O	+	O	+	O	O
Hartebeest	-	-	O	O	-	-
Hippo	+	O	O	O	+	+
Hyaena	+	O	O	+	+	O
Impala	+	O	O	O	O	O
Kudu	-	O	O	+	O	O
Leopard	O	+	+	+	+	-
Lion	+	O	O	O	O	O
Puku	O	O	O	O	+	O
Reedbuck						
Roan	-	-	O	O	O	-
Sable						
Warthog	O	-	O	O	O	-
Waterbuck	- (+)	-	O	+	-	-
Wildebeest	-	O	+	O	O	-
Zebra	+	-	O	O	-	+
Total +	10	4	7	9	9	4
Total O	6	10	13	11	7	9
Total -	4	6	0	0	4	7
Rank	2	3	1	1	2	3

2) Community quotas

Community members selected to be on local resource management committees were given training to use the above data to base their decisions on setting next year's hunting quota for their area. The process was a participatory exercise involving members of the community, technical staff from the National Parks and Wildlife Service and representatives of the hunting industry in the area. Approximately four to six hours were required to complete the exercise per concession area. Quotas were derived in this way for six hunting concessions for the 1999 hunting season and results are summarized in the table below.

Table 2.

Concession	Total Quota	Safari Quota
Chanjuzi	134	105
Chifunda	179	117
Chikwa	185	139
Luawata	145	116
Mwanya	185	112
Nyampala	194	121

Number of species hunted on these quotas varied from 19 to 24. Certain species are highly valued and also occur in relatively low densities and thus most vulnerable to effects of over-hunting. Except for lion and leopard, these species and their corresponding quotas for the above areas are shown in the table below. They also represent the species used in this study to assess the accuracy of these indirect measures used in describing population trends and setting hunting quotas:

Table 3								
Concession	Buffalo	Eland	Hartebeest	Kudu	Roan	Waterbuck	Wildebeest	Zebra
Chanjuzi	20	2	1	3	1	0	0	6
Chifunda	25	2	0	6	2	0	7	6
Chikwa	16	1	6	6	3	2	8	7
Luawata	24	2	4	4	2	1	8	8
Mwanya	26	1	1	2	1	1	0	12
Nyampala	23	2	1	6	3	3	10	17

3) Predictions tested and data collected

Prediction 1: If the above quotas accurately reflect actual population differences as based on the various indicators used to set quotas, then population estimates based on an aerial survey should have a similar ranking as the value of quotas. If this is proven true, then it could be argued that these same indicators might provide a valid basis for evaluating population trends of hunted populations.

To test this prediction the eight species given in the above table were counted by an aerial census for each of the six hunting concessions. The aerial survey was conducted in late August to remove any possible effect from non-resident and resident hunting, which begins 1 September. The sampling intensity used was 20% and the survey team was not told what the predictions were or what results were expected as based on quota differences.

Prediction 2: If community quota setting is a process that tracks hunting results and third-part interviews by making iterative adjustments based on evaluations of these indicators, then percentage use of quotas should show an initial increase until use is balanced by production.

To test this prediction percentage use of quotas are compared from 1996 to 1999 for all six areas. Community quota setting began for 1998 hunting quotas.

Prediction 3: If third party assessments of population trends are valid, results from respondents who were interviewed should show consistent patterns between local village scouts who patrol the area and the resident professional safari hunter who guide clients in the hunting area. Population trends were also compared with population estimates obtained from the aerial survey results. This assumed that in most cases declining populations also tended to have the lowest populations.

To test this prediction, a formed questionnaire was used to interview resident scouts and resident professional hunters.

Results:

1. Correlation between quotas and estimated population sizes

Of the eight species examined, three showed a positive correlation (hartebeest, wildebeest and zebra) but only for zebra was this correlation significant at the $p < .05$ level (Spearman rank

correlation). Both Kudu and Waterbuck tend to associate with riverine thickets where visibility from the air is poor, and not surprisingly, neither showed any positive correlation. Eland and roan would have been visible from the air: eland in open grasslands and roan in open woodland that would have lost its leaves. Both species are known to occur in low density and are usually found in groups. Such a dispersion pattern normally contributes to high sampling errors and the sampling intensity used in this survey may not have been sufficient to sample these species accurately. Buffalo and to a less extent eland have a very large range and frequently move back and forth between the adjacent national parks and concession areas (see Figure 1). Because the aerial survey was restricted to concession area boundaries due to cost and time limitations, the actual population of these two species were likely to be under-sampled in terms of the total population exposed to licensed hunting. Results of these correlation tests are given below:

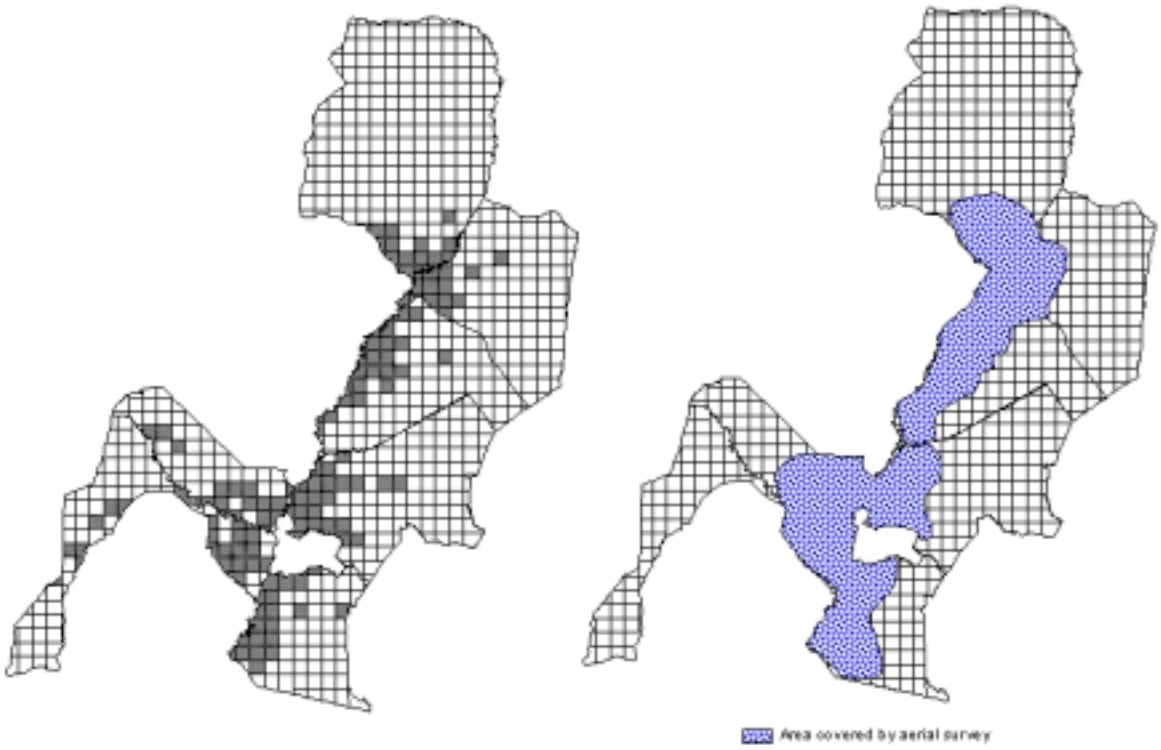
Buffalo	**Quota**	**Count**	**Hartebeest**	**Quota**	**Count**	**Roan**	**Quota**	**Count**	**Wildebeest**	**Quota**	**Count**
Chikwa	16	373	Chifunda	0	10	Chanjuzi	1	0	Chanjuzi	0	281
Chanjuzi	20	111	Chanjuzi	1	0	Mwanya	1	5	Mwanya	0	92
Nyampala	23	1574	Mwanya	1	21	Chifunda	2	0	Chifunda	7	518
Luawata	24	1418	Nyampala	1	5	Luawata	2	0	Chikwa	8	215
Chifunda	25	518	Luawata	4	30	Chikwa	3	0	Luawata	8	283
Mwanya	26	273	Chikwa	6	40	Nyampala	3	5	Nyampala	10	523
r = .08 (.84)			**r = .70 (.12)**			**r = 0 (1)**			**r = .5 (.17)**		
Eland			**Kudu**			**Waterbuck**			**Zebra**		
Chikwa	1	0	Mwanya	2	31	Chanjuzi	0	0	Chanjuzi	6	0
Mwanya	1	21	Chanjuzi	3	15	Chifunda	0	0	Chifunda	6	0
Chanjuzi	2	0	Luawata	4	30	Luawata	1	0	Chikwa	7	42
Chifunda	2	0	Chifunda	6	0	Mwanya	1	93	Luawata	8	74
Luawata	2	64	Chikwa	6	0	Chikwa	2	40	Mwanya	12	31
Nyampala	2	25	Nyampala	6	10	Nyampala	3	0	Nyampala	17	284
r = .20 (.62)			**r = -77 (.04)**			**r = .18 (.64)**			**r = .71 (.05)**		

These results provide limited support to the use of indirect measures used by ADMADE for setting quotas and describing population trends, given the weak correlation found for hartebeest and wildebeest. However, their positive correlation values were consistent with the more favorable sampling conditions as compared with other species sampled, which suggests that aerial surveys may provide a relatively poor basis for estimating quotas for species that are:

a) relatively secretive or found beneath thick foliage,
b) occur at densities too low to accurately count at sampling intensities below 20% (most aerial surveys use a much lower sampling intensity between 6 and 10%), or
c) have ranges exceeding the limits of the survey.

It is salient to point out that these conditions are valid for many of the more valuable species and therefore the ones most likely to be over-hunted. These include the following species in Zambia: lion, leopard, buffalo, waterbuck, eland, kudu, and roan.

Figure 1. Shaded grids where animals were hunted by safari clients in 1998 (left) and area covered by aerial survey in 1999 (right).



2) Percentage use of quotas

Table 4 provides the percentage use of safari hunting quotas from 1996 to 1999. Prior to 1998, quotas were exclusively set by a Government appointed panel of people with limited empirical data to base their decisions. For 1998, communities in ADMADE areas undertook their first quota setting exercise. Their quota recommendations were largely not accepted by this panel, which served as the final approving authority. For the 1999 quota, however, the panel endorsed the community recommendations with relatively few changes.

Table 4.

Year	Chanjuzi	Chifunda	Chikwa	Luawata	Mwanya	Nyampala	Average
1996	67.8%	67.4%	46.0%	36.4%	66.7%	63.4%	57.9%
1997	66.4%	69.0%	77.8%	52.1%	39.8%	59.7%	60.8%
1998	67.4%	50.4%	55.6%	57.9%	76.2%	67.5%	62.5%
1999	64.8%	54.7%	56.8%	90.5%	90.2%	92.6%	74.9%

In contrast to the previous years, the percentage use of quotas for 1999 averaged a marked increase for Luawata, Mwanya and Nyampala. This was observed for Chanjuzi, Chifunda, and Chikwa and various factors may have contributed to this difference:

a) quotas were too high and required further reduction
b) professional hunter guides for these areas were new to the area and did not know the area well enough to find suitable trophy animals
c) these areas suffered higher levels of land use disturbances which lowered hunter success.

Chanjuzi, Chifunda, and Chikwa all had new professional hunters, whereas Luawata, Nyampala and Mwanya areas had professional hunters with over five years of current experience in their respective areas. This factor may have been important and possibly masked the effect of reduced quotas, especially for Chanjuzi and Chifunda where quotas were significantly reduced from previous year's quotas (see Table 5).

Table 5

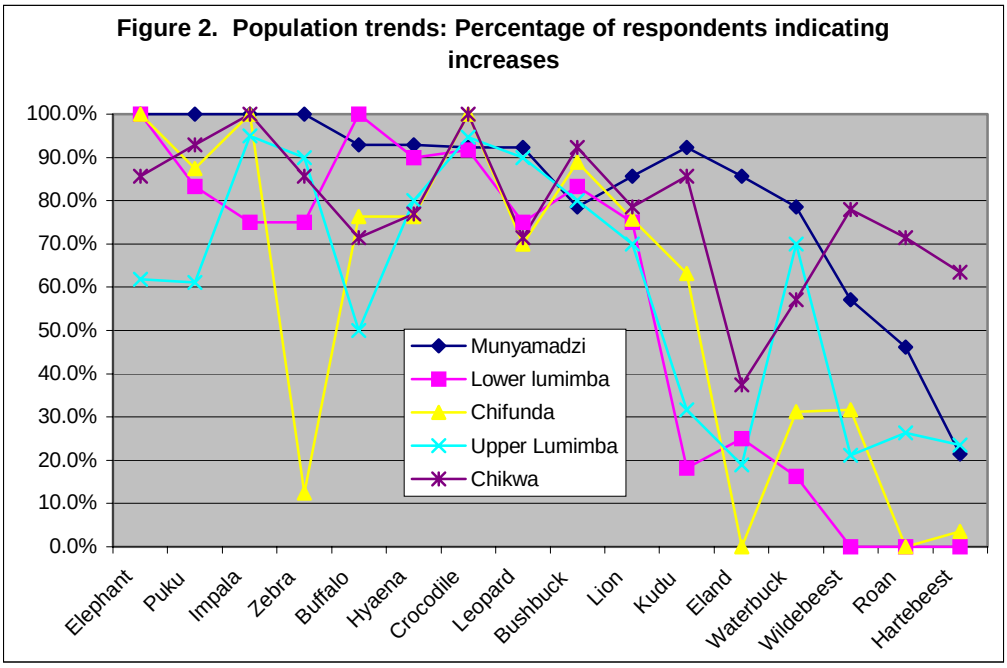
Year	Chanjuzi	Chifunda	Chikwa	Luawata	Mwanya	Nyampala
1996	177	190	235	187	183	194
1997	152	158	180	146	166	159
1998	144	129	135	114	122	120
1999	105	117	139	116	112	121

Land use disturbances are difficult to quantify and compare, although results from safari client interviews, which included comments on disturbances that may have limited their hunting success, did not show a pattern consistent with the increases in percentage use of quotas.

3) Third-party assessments of population trends

Figure 2 examines the results of a questionnaire survey administered to wildlife scouts working in a given concession area for three or more years. Data in this figure represent the inverse percentage of respondents who felt that animals have either decreased or remained unchanged. The value for 'decreased' as opposed to "unchanged" was weighted by a factor of two to provide a stronger contrast for those species respondents believed were unchanging. This weighting was based on the subjective impression among the questionnaire enumerators that respondents tended to be more biased toward population increases than decreases. Results therefore gave a more conservative approach for describing an increasing population trend. Elephants are not hunted but are included because of their importance as a potential indicator of poaching by illegal hunters who typically originate from outside the area.

Results suggested eland, wildebeest, roan and hartebeest have a relatively low score for a positive population growth trend in most areas and waterbuck and kudu in two areas. All of these species are low density, are generally found in groups, and have a dry season distribution range limited to waterholes. Only in Chifunda do zebras appear to be decreasing. All other species, including buffalo (except for Upper Lumimba) and the big cats were found to be generally increasing.



To test the validity of these trends, collaborative results from other independent sources were used. The particular case in Chifunda where Zebra were found to be decreasing offered an excellent test of the 'third-party assessment' approach. The area professional hunter was new to the area in1999. He had been in the area for two months when he was interviewed on his impressions of species' populations. Zebra was singled out as being 'surprisingly absent'. The professional hunter guide had hunted the area in previous years and remembered zebra as being common as compared to the current situation. The same person also confirmed a very healthy and abundant population of kudu, which was corroborated by the scout respondents. In Munyamadzi's two hunting concessions, Nyampala and Luawata, the professional hunters from both areas have been resident guides in these areas for over three consecutive years with about 120 days per year of guiding safari clients in the area. This made it possible to compare their responses with those of the scouts. Respondents from both samples were independently interviewed and were questioned by the same enumerator. From a graphical analysis (see Figure 3) showing percentages of respondents who described population trends as either increasing or decreasing, a high degree of similarity was found. Exceptions included two species which scouts suggested were decreasing: eland (7%) and roan (14%), whereas the PHs believed their populations were either unchanging or increasing. Total species sampled in this survey was 16, and from these results only hartebeest had a consistently high score for decreasing for both scouts and PHs. To a lesser extent the same was true for wildebeest and waterbuck. The preliminary conclusion from these data is that most species in Munyamadzi are increasing while hartebeest is decreasing as are wildebeest and waterbuck, but less so. Status of eland and roan populations is not clear from this analysis but conservatively were regarded as unchanging.

An independent comparison of these results was taken from the aerial survey results (see Table 4). Among the key species surveyed and easily counted from the air, a high degree of consistency was found with results of the questionnaire survey:

A. Zebra: there were more sightings of zebra in Nyampala than any other hunting block. There were no zebra counted in Chanjuzi and Chifunda while only one sighting was made in Chikwa. These results were consistent with the respondent survey:
    a. Chifunda scored the lowest percentage for increasing
    b. Nyampala (Munyamadzi) had the higher percentage
    c. Chanjuzi and Chikwa scorings were inconclusive for comparing with the aerial survey results.
B. Hartebeest: sightings were few with most of them comprising only one individual. Chikwa and Chanjuzi had no sightings at all. The respondent survey game similar results, revealing a general trend for decreasing among all areas surveyed.
C. Buffalo: lowest numbers were observed in Chikwa and Chanjuzi. The respondent survey Chikwa and Chanjuzi had the highest values for decreasing trends.
D. Wildebeest: highest numbers were Munyamadzi and Chifunda and lowest numbers were recorded in Mwanya and intermediate size populations were recorded in Chanjuzi and Chikwa. The respondent survey was consistent for Mwanya, which showed a declining population while Munyamadzi and Chikwa areas had the highest values for increasing trends.

4) Interpretation of results in relation to improving wildlife production

The above results allow a preliminary analysis of population trends in relation to ADMADE efforts to increase wildlife production through community involvement as an accepted form of

land use. The basis for this analysis is based on inferences from trends generated from third-party assessments (Figure 2) and the scoring of indicators based on hunting results (Table 1). What is very clear from a very broad interpretation is that population trends for most species sampled in these areas are generally increasing or are unchanging. Exceptions apply mostly to hartebeest, roan, eland and wildebeest. With the exception of wildebeest, these species occur in hilly country away from the riverine area and are generally more exposed to poaching in areas where there are few or no settlements nearby. This is in strong contrast to those species occurring in the riverine areas. This would suggest that communities living in ADMADE areas are generally promoting wildlife production, given their proximity to wildlife concentrations. It would also suggest, however, that not all species are benefiting from this community approach and community leadership promoting improved wildlife production have yet to find viable solutions to ensure all areas on communal lands are safe for wildlife.

Discussion

ADMADE has developed a community-based approach to collecting data for use in setting quotas to support the sustainable use of wildlife resources on communal land in Zambia. This data collection is entirely done by local residents trained as village scouts. The analysis of these data is done through local resource management committees whose members have been given formal training in this skill. Such self-sufficiency in resource management skills at a community level is an important objective of community-based resource management (CBNRM) programs.

The assumption this approach depends on is that the various indirect ways used by ADMADE to measure populations trends are sufficiently correct to set hunting quotas. More conventional approaches, such as aerial surveys and ground transects, are considered too expensive or too unreliable, though these approaches do represent more direct ways of counting animals. Unfortunately, a number of variables tend to confound their interpretation and make conclusions drawn from them vulnerable to sampling errors. As a result, indirect measures undertaken by local residents on a consistent annual basis might be preferable and more accepted if this methodology could be scientifically tested and proven valid.

This paper has undertaken a test of three predictions based on the results of these indirect measures. In all three tests, there were no strong evidence to reject their validity as an accurate, low cost approach to monitoring wildlife populations trends, nor do these tests reject the appropriateness of these indicators for setting hunting quotas.

In the first prediction, quotas for key economic species were ranked and compared with population estimated determined from an aerial survey using an unusually high sampling intensity survey of 20%. High positive correlation coefficients were found for three species: hartebeest, wildebeest, and zebra. These were species that could be sighted relatively easily from the air. In the case of buffalo, eland and roan, which would also have been visible from the air, no correlation was found. The latter two species are relatively rare and hyper-dispersed, increasing the risks of not being seen on an aerial survey, even with a sampling intensity of 20%. In the case of both the buffalo and eland, populations of these species range widely and often move to and from adjacent national parks. Because the aerial survey was

limited to the hunting concessions, estimates of these populations would likely have been undercounted in some cases.

These discrepancies provide useful insights into the limitations of aerial surveys and suggest aerial surveys are not appropriate for species not easily sighted from the air. In Zambia with its many riverine and thicket-type habitats, species like kudu, waterbuck, bushbuck, leopard and lion would be inappropriate for counting from the air. Other species that occur too infrequently because of their dispersion pattern or have ranges exceeding the counting area may also limit the usefulness of aerial surveys. This would suggest, therefore, that indirect measures may, in fact, be a far more accurate way to interpret population trends for setting quotas.

In the second prediction, percentage use of hunting quotas were examined to test whether percentage use increased with the advent of community quota setting. Previous quota setting had limited data to base quota decisions on and percentage use rarely exceeded 70%. With the use of indirect measures employed by local resource management committees in setting their own hunting quotas, percentage use would be expected to increase if quotas were being set accurately. This prediction was found true for three out of six samples. In the other three, additional factors may have had an over-riding effect. In all three areas the resident professional guide had not hunted in their respective areas in recent years, unlike the professional guides from areas where percentage use was high. This appeared to be likely influence in at least two of the areas where quotas had been significantly reduced from the previous year.

The third prediction tested the validity of directly interviewing people most knowledgeable about wildlife populations in their respective concessions, namely resident scouts and resident professional hunting guides. The test examined how well results from the scout's sample collaborated with that of the resident professional hunters. Variation in population size from the aerial survey census was assumed to correlate with population growth trends and were compared with interview results for those species the aerial survey could most accurately count: wildebeest, hartebeest, zebra and buffalo. Results showed a high degree of agreement and provided support for knowledgeable third-party assessments as a valid, low-cost approach to establishing qualitative measures for population growth trends.

Results from these three tests provide a preliminary validation of the usefulness of the indirect measures used by ADMADE for setting quotas and estimating population growth trends. The significance of these results is that resident communities can be trained to do the work that traditionally was believed best done by outside experts who depended on aerial survey techniques. These results do not invalidate this argument but have questioned their appropriateness for all species. This point does raise the concern that species not appropriately counted from the air are vulnerable to inaccurate quota setting unless other methodologies are developed and tested. These results provide a contribution toward this need and further recognize the notion that developing co-management relationships in Zambia between communities and Government on ways to improve wildlife management can create novel innovations for improving management approaches.

Because the data used in this study are being collected locally and are available to community leaders, a real opportunity now exists for local leadership to use these data to analyze possible threats to their wildlife resources and to seek solutions in a pro-active manner. ADMADE is at an important stage where the capacity to undertake such decisions and actions, as a process of self-evaluation and management planning, can be tested through the current role of the newly constituted, democratically elected Community Resource Boards. Whether this leadership will meet this challenge is yet to be seen but what this paper has demonstrated is that data currently being collected at a community level is of sufficient quality to for this leadership to make technically correct management decisions.

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